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Thinking Outside the Pond: Benchmarking Performance Expectations for Deep-water Reservoirs Using Analog Data from the Gulf of Mexico

Industry has a considerable knowledge base from the central Gulf of Mexico (GOM) slope, yet to what extent can this database provide valid analogues for other slope systems? The GOM is viewed as an end-member above-grade ponded slope system in many conceptual models. This end-member status leads to both a de-emphasis of the value of applying knowledge derived from the GOM elsewhere and the value of applying knowledge from other slope systems to the GOM. But, the GOM slope contains examples of both a) ponded reservoirs (where receiving basin topography trapped entire flow volumes transported by variable flow sizes) and b) cases where flows of variable size and volume were far less affected by confining topography and hence have potential as partial analogues for comparable (dimensions, grain size) systems in less topographically confined settings.

The Brazos-Trinity depositional system consists of four linked intraslope basins (I – IV) located on the upper slope, offshore Texas and represents a type locality for understanding general aspects of stepped above-grade slopes and specific aspects ponded above-grade slopes. Conceptual understanding of the fill history in these basins include 'fill and spill' models where basins fill sequentially in the seaward direction, to models which invoke coeval basin filling with the coarse fraction retained preferentially in the up-dip basins and synchronous early bypass of the fine fraction to down-dip basins. Integration of recent coring results with nearly complete 3d seismic coverage has improved age dating and reconstruction of infill history. Initially flows bypassed the upper basins, forming the basal deposits in Basin IV. Deposition of high net/gross sands in Basin II resulted from stripping of muds suspended high within the flows entering the basin. These mud-prone flows exited Basin II through a tributary-like flow gathering zone near the basin exit point and ponded in the lower part of Basin IV. The upper fill in Basin IV comprises a

submarine apron that is sourced by a continuous channel system directly from a lowstand delta located in Basin I. Within this apron, the observed seaward tapering is controlled by lower-efficiency sandy sediment gravity flows of relatively low volume with respect to basin size. Although high amplitude sea level fluctuations during the last glacial-interglacial cycle have modified the accumulation of sediment in Basin IV, the newly acquired data from Basins IV and II show that basin tectonics and flow dynamics also exerted a strong influence in sediment fill distribution through space and time.

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The slope geometry and stratigraphic architecture for the upper fill of a typical GOM intraslope basin is similar to that observed across stepped-slope profiles documented from many continental margins including the Niger delta, NW Borneo, SE Brazil, Lower Congo and Tanzania. Because a primary control on reservoir distribution and architecture across varied slope profiles is the interaction between local gradient change and flow/grain size, analogous stratigraphic architectures may be developed at different absolute slope positions. Therefore there is potential to use the quantitative data from the GOM, after careful selection of appropriate analogues, to help constrain, a) net/gross distributions for use in STOIIIP estimates from calibrated seismic facies and b) expectations of reservoir performance and reserves estimates in other basins. ■

Biographical Sketch

BRADFORD PRATHER is a geological advisor in the R&D unit of Shell International E&P. He has been a leader of Special Studies and Research Teams from 1992 to the present.



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Starting in 1996 he has directed turbidite research for this group in Shell. During this time he developed a broad-based conceptual geologic model for characterizing slope and base-of-slope systems. He has made numerous contributions to the science of geology covering aspects of exploration and production in a wide variety of depositional settings. He is the recipient of the University of Kansas Erasmus Haworth most distinguished alumni

honors in geology, the AAPG Jules Braunstein Award, two AAPG J. C. "CAM" Sproule Memorial Awards, and has toured as an AAPG Distinguished Lecturer. In addition to his duties at Shell he serves as a shore-based scientist for the Integrated Ocean Drilling Program (IODP) Expedition 308, and on scientific committees for the NSF, AAPG and SEPM.

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Over the years, several lines of evidence brought this hypothesis into question. Linear hot spots from different plates yielded contradictory rates and directions. Furthermore, the isotopic chemistry of the volcanics at some hot spots requires an unrealistically large number of isolated mantle source reservoirs, if the plume hypothesis is to be maintained, at least in its present form.

Recent work in the western Pacific plate by Hirano et al. (2006) has led scientists to hypothesize that partial melts from the asthenosphere have risen along fracture zones created by plate flexure in turn caused by plate subduction to the west. They conclude that while some hot spots are related to mantle plumes, others are related to different processes, such as flexure. ■

For further reading see

www.sciencemag.org/cgi/content/full/313/5792/1394

References

- Hirano et al., *Science* 313, 1426 (2006), 10.1126/science.1128235, Originally published in *Science Express* on 27 July 2006.
Marcia K. McNutt, 2006: Another Nail in the Plume Coffin? *Science* 8 September 2006:
Vol. 313, no. 5792, pp. 1394 – 1395 DOI: 10.1126/science.1131298. Originally published in *Science Express* on 27 July 2006.

The Economics of Global Warming

In a report issued recently Sir Nicholas Stern, a senior government (UK) economist and former chief economist for the World Bank, estimated the cost of the impending global warming crisis could eventually be as high as 20% of the world's gross national product (GNP) unless immediate action is undertaken to mitigate the rising temperatures and the rapid changes in climate that are the result of increasing levels of CO₂ and other greenhouse gasses in the atmosphere. The British government report went on to estimate that the cost of this remediation would likely be only 1% of the world's GNP, if the nations of the world act now. In the wake of the report, Prime Minister Tony Blair called for decisive action on carbon emissions. The report calls for spending to be doubled worldwide on research into low-carbon technologies.

According to a recent article by Andrew C. Revkin in the *New York Times* (NYT), Washington's current approach to global warming is in stark contrast to that of Tony Blair's government. The Bush and previous administration decided not to ratify the Kyoto protocol that called for far more moderate cuts in carbon dioxide emissions than those suggested by the Stern report.

According to the NYT article annual federal spending in the United States for *all* energy research has fallen to \$3 billion a year in the current budget from an inflation-adjusted peak of \$7.7 billion in 1979. Federal spending on medical research, by contrast, has nearly quadrupled, to \$28 billion annually, since 1979. Military research has increased 260 percent, and at more than \$75 billion a year is 20 times the amount spent on energy research. President Bush has sought to increase the energy research budget to \$4.2 billion for 2007, but that would still be a small fraction of what most climate and energy experts say is needed.

The UK newspaper *The Guardian* reported that the British government hired Al Gore, former vice president, presidential candidate and producer of the film "An Inconvenient Truth," to advise on global warming issues. Gore's film, warning of the need for the US to address global warming, was strongly maligned by some conservative critics and pundits but widely acclaimed by many others. One supporter is Arnold Schwarzenegger, the Republican governor of California, who has recently introduced initiatives for the state that will put a cap on carbon-dioxide emissions from manufacturing plants and set targets for less-polluting cars. ■

For further information see:

- BBC NEWS: http://news.bbc.co.uk/go/pr/fr/-/2/hi/in_depth/6099272.stm, published: 2006/10/30 17:16:27 GMT.
James Randerson and Tania Branigan, 2006: UK signs Gore to sell climate case in US. *The Guardian*, Monday October 30, 2006
Andrew C. Revkin, 2006: Budgets Falling in Race to Fight Global Warming, article in the *New York Times*, October 30, 2006.

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